CHANGE ISSUE – RTCA/DO-242

MASPS for ADS-B Rev. A

Tracking Information (committee secretary only)	
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Short Title for Change Issue:	Determination of the Airborne/On-Ground Status

MASPS Document Reference: DO-242A		Originator Information:	
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Proposed Rationale for Consideration (originator should check all that apply):	
	Item needed to support of near-term MASPS/MOPS development
Y	DO-260/ED-102 1090 MHz Link MOPS Rev A
	ASA MASPS
	TIS-B MASPS
Y	UAT MOPS and SARPS
	Item needed to support applications that have well defined concept of operation
	Has complete application description
	Has initial validation via operational test/evaluation
	Has supporting analysis, if candidate stressing application
Y	Item needed for harmonization with international requirements
Y	Item identified during recent ADS-B development activities and operational evaluations
Y	MASPS clarifications and correction item
	Validation/modification of questioned MASPS requirement item
	Military use provision item
	New requirement item (must be associated with traffic surveillance to support ASAS)

Nature of Issue:		Editorial	Y	Clarity	X	Performance		Functional

Issue Description:

In the beginning there was the 1090 MHz MOPS (DO-260) and all was well with the world! And then, a darkness fell upon the earth because some people believed that there were errors or omissions in the very basis upon which the 1090 MOPS was built. A group of wise men were gathered together to discuss the possible changes to the most sacred book, the ADS-B MASPS (DO-242). During the process of their changes, they looked upon the 1090 MOPS and thought to themselves that it was so perfect that they should draw wisdom from it for their own document. From the 1090 MOPS (DO-260) they pulled the basis for the development of Table 2-9A (*Determination of Surface Position Message Broadcast when there is no means to automatically determine vertical status*) and placed those requirements into textual language and it became §3.4.3.1.1(4) in DO-242A. They also pulled the basis for the development of Table 2-9B (*Validation of "On-Ground" Status*) and placed those requirements into textual language and it became §3.4.3.1.1(6) in DO-242A. Unlike the creators of the original 1090 MOPS, the creators of the revised ADS-B MASPS (DO-242A) were only human, and thus, they made mistakes!

Error #1: In their zeal to translate DO-260 Table 2-9A into text, the creators of DO-242A incorrectly stated the requirement for Radio Height in §3.4.3.1.1(4) as **RH < 100 feet**, when it should have been **RH < 50 feet**, as originally stated in Table 2-9A of DO-260.

(*Continued on Next Page.*)

Issue Description (*continued*):

Error #2: Just so that Error #1 would not be so easy to find, the creators of DO-242A additionally incorrectly stated the requirements for Radio Height in §3.4.3.1.1(6) as **RH > 100 ft**, when it should have been **RH > 50 ft**, as originally stated in Table 2-9B of DO-260.

After the good book of ADS-B MASPS (DO-242A) was published, others decided to follow it religiously and they created the requirements for the Universal Access Transceiver (UAT MOPS – DO-282). The creators of DO-282 had so much faith in the creators of DO-260 and DO-242A that they tried to copy Tables 2-9A and 2-9B, from DO-260, but, also being human, when they created Table 2-17 in DO-282, they created the same error as did the creators of DO-242A. They used the value of **RH < 100 feet** instead of correctly using the value of **RH < 50 feet**.

When it came time for the congress of the wisest of all men (RTCA SC-186 Plenary) to convene to approve the UAT MOPS (DO-282), one of their group, Steve Horvath of UPS-AT did try to warn the creators of DO-282 that there were errors (as documented in the Consolidated Comments for the Draft UAT MOPS, RTCA Paper number 132-02/SC186-196). But instead of finding and correcting the errors, WG-5 punted the problem back over the fence to WG-6 for review. But, the wise Steve Horvath went even further! He stated that in his opinion, the conditions of Table 2-17 in DO-282 should be "AND'd" together instead of being "OR'd" together. Again, WG-5 punted the problem back to WG-6 for further review.

And, then, the most-wise group of all began their review of the UAT MOPS for the purpose of creating the International Civil Aviation Organization UAT Standards and Recommended Practices (ICAO UAT SARPS). This group of wise men came upon Tables 2-17 and 2-18 in the UAT MOPS as they were being proposed for the UAT SARPS Technical Manual and they asked the same questions that had been asked a year before by Steve Horvath. This time, there came an answer from on high!

The answer is that there are clear and undisputed errors in DO-242A §3.4.3.1.1(4) and (6), and also in Table 2-17 of the UAT MOPS DO-282. But further analysis is necessary! It is also potentially correct that it might be better to think of the determination of the Airborne and On-Ground conditions differently. What is found in Attachment A is an attempt by Alessandro Capretti, ICAO AMCP Secretariate, to clarify what he believes is the flawed logic in the creation of the following tables and text. If you have not kept up to this point, now is the time to pay attention:

Originally:
Table 2-9A and Table 2-9B were created in the 1090 MHz MOPS (DO-260), and then they became Paragraph 3.4.3.1.1(4) and 3.4.3.1.1(6) in ADS-B MASPS (DO-242A), which got translated/copied into Table 2-17 and Table 2-18 of the UAT MOPS (DO-282), which have now been copied as
Table 3-12 and Table 3-13 in the UAT SARPS Technical Manual
BUT, they remain in their original form as Tables 2-9 and 2-10 in the new 1090 MOPS (DO-260A).

Attachment A was written specifically against the UAT SARPS Technical Manual by Alessandro Capretti in hopes that there would be a debate/discussion to decide to simplify all of the above Tables/text. It is also possible that Table 2-18 in the UAT MOPS (and hence Table 3-13 in the UAT SARPS Technical Manual) can be eliminated altogether specifically for UAT.

Please now share in the knowledge that is Attachment A.

THE END

Originator's proposed resolution:

(1) Correct the obvious errors in the text of the ADS-B MASPS (DO-242A) and in Table 2-17 of the UAT MOPS (DO-282)
(2) Debate whether or not to totally modify the determination of Airborne/On-Ground Status, based on the recommendations of Steve Horvath and Alessandro Capretti

Working Group 6 Deliberations:

WG6 has not formally reviewed this Issue Paper to date.

UAT Manual

Determination of Vertical Status (AIRBORNE vs ON-GROUND condition)

Problems with current text (Rev. 0.2 of Manual)

The condition of Table 3-13 of the draft UAT Manual for declaring AIRBORNE overriding an ON-GROUND condition determined by automatic means is the following:

(air speed>100) OR (ground speed>100) OR (radio altitude>50)

If we define three boolean variables, A, B and C as follows:

A=(air speed>100) ;
B=(ground speed>100);
C=(radio altitude >50) = C

then the condition of Table 3-13 can be written:

(1) **IF** (A **OR** B **OR** C) = **TRUE,** **THEN** AIRBORNE

(even though ON-GROUND condition is reported by automatic means).

The condition of Table 3-12, on the other hand, says that, if you do not have any automatic means of determining your vertical status, you should consider the system ON-GROUND if and only if:

(air speed<100) OR (ground speed<100) OR (altimeter<50)

This can be expressed with the same variables A, B, and C as above:

(2) **IF** [(**NOT** A) **OR** (**NOT** B) **OR** (**NOT** C)] = **TRUE,** **THEN** ON-GROUND

Of course, if condition (2) is **FALSE** instead of **TRUE**, you declare AIRBORNE, i.e.:

(2)' **IF** [(**NOT** A) **OR** (**NOT** B) **OR** (**NOT** C)] = **FALSE,** **THEN** AIRBORNE

But in Boolean logic the following expression appearing in (2) and (2)':

[(**NOT** A) **OR** (**NOT** B) **OR** (**NOT** C)]

is always equal to

NOT (A **AND** B **AND** C)

(because both expressions are TRUE if and only if at least one of the input variables is FALSE).

Hence condition (2)' can be rewritten as:

IF [**NOT** (A **AND** B **AND** C)] = **FALSE,** **THEN** AIRBORNE

or equivalently:

(3) **IF** (A **AND** B **AND** C) = **TRUE,** **THEN** AIRBORNE

If you now compare (1) and (3) you can see the problem. Condition (3) does a logical AND of the input variables, so all three variables must be true for the system to declare AIRBORNE. Contrast this with Condition (1), where only one of the variables being true is sufficient to declare AIRBORNE (because a logical OR is used). In other words, Condition (3) is much more restrictive.

Thus, the system behaves in an illogical (in fact, perverse) manner. It is much more likely to declare AIRBORNE if it has a ground switch that says "GROUND" (because it then applies the more relaxed condition (1)), than if it does not have a ground switch at all (because it then applies the more stringent condition (3)). Assuming that the original intent (as stated in the meeting) was to "err on the side of safety" by declaring "AIRBORNE" when in doubt, the intent is satisfied by (1) but not by (3). So (3) seems wrong and certainly inconsistent with (1).

An obvious fix would be to rewrite Table 3-12 in terms of AIRBORNE instead of ON GROUND. i.e.

IF (A **OR** B **OR** C) = **TRUE,** **THEN** AIRBORNE

which works out as:

(5) **IF** [(air speed>100) **OR** (ground speed>100) **OR** (radio altitude>50)] **THEN** AIRBORNE

This formulation has the advantage of directly showing that the logic applied is the same as Table 3-13. In fact, it is not clear why Table 3-12 was not formulated in terms of determination of AIRBORNE (instead of determination of ON-GROUND, as is currently the case). Perhaps there is some reason that was unkown to the SWG which explains why the current formulation of Table 3-12 was chosen. Perhaps that reason may also provide an explanation of why the inconsistency should be accepted – but so far I have not heard any such explanation.

Alternatively, if the formulation of Table 3-12 in terms of ON-GROUND were to be preserved, the ORs would need to be replaced with ANDs to achieve the same result:

(6) IF [(air speed<100) AND (ground speed<100) AND (altimeter<50)]
THEN ON-GROUND